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ABSTRACT

This series of studies was concerned with developmental changes in memory organization. Denney & Ziobrowski's (1972) "complementary-similarity" shift with age in the bases of encoding for memory was investigated with two new paradigms which assessed memory performance for the same stimulus materials within the same subjects. No evidence was found to support the differential memory organization hypothesis. The results are interpreted in terms of information availability and strategy effectiveness. (Author)

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Associative Bases of Encoding: An Age-Related Dimension?

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Today I would like to discuss two new paradigms we used to assess children's memory organization. The first is a cued recall paradigm introduced by Tulving & Watkins (1975) and the second is a free recall task which allowed us to assess preference for different clustering dimensions within the same list. We believe these methods are advantageous because direct comparisons of the utility of different organizational dimensions were made, using the <u>same</u> stimuli within the <u>same</u> subjects.

Let me put these studies into context. Evidence from a variety of areas suggests that children categorize according to different criteria than adults. For example, in free classification studies, Piaget & Inhelder (1964) found that with increasing age there is an increase in groupings based on similarity <u>among</u> items and a decrease in groupings based on similarity <u>between</u> items. Some researchers believe that children and adults use categorizing criteria differentially to aid memory as well. (Denney & Ziobrowski, 1972). In the past, studies dealing with developmental shifts in attribute encoding have compared childrens' preferences for different dimensions between subjects or between stimulus conditions for the same subjects. For example, a study conducted by Denney & Ziobrowski (1972) compared children's and adults' clustering on two different categorized lists. One list consisted of word pairs which were complementary associates (needle-sew) and the other list consisted of word pairs which were similarity associates (king-ruler). The terms complementary and similarity refer to associations based on functional relatedness and grammatical relatedness, respectively and are somewhat analogous to the terms 'syntagmatic' and 'paradigmatic' in word association studies. Denney & Ziobrowski (1972) found that first graders' clustering was significantly higher on the complementary list than on the similarity list and that the reverse was true of college students' clustering. They concluded that there was a complementary-similarity shift with age in bases of memory organization.

It has been fairly well documented that these dimensions are used differentially by children and adults as categorizing criteria in nonmemory tasks (Brown & Berko, 1960; Ervin, 1961). Because the complementary-similarity shift is so well known, we decided to investigate it further by comparing the dimensions directly, using the <u>same</u> words within the <u>same</u> subjects.

In our first study, we employed Tulving & Watkins' (1975) cued recall paradigm to assess patterns of memory organization with respect to complementary and similarity dimensions. We had 24 third graders, 24 sixth graders, and 35 college students learn two eight-item lists of target words. These stimulus lists are presented in Table 1. Each list was followed by a three-minute interpolated task which consisted for children, of circling numbers and for adults, of working simple math problems. Then two cues were presented for every target item on the list. One cue represented a complementary relationship and the other cue represented a similarity relationship. For example, the target item <u>Horse</u> was cued by <u>Gallop</u> and by <u>Pony</u>. The order of cue presentation was balanced so that complementary cues preceded and followed similarity cues for the same items an equal number of times and so that the position of cues within the total list of 16 was varied.

The number of words recalled by each subject to complementary cues alone, to similarity cues alone, to both cues, and to neither cue were tabulated. This data was averaged across subjects and converted to valences which represented the proportion of recall accounted for by each of these cells. A correction factor was applied to partial out order effects and a final 'reduction matrix' representing the 'average' pattern of recall for each age group was derived.

Figure 1 will help illustrate what we mean by a 'reduction matrix'. In accord with the encoding specificity hypothesis (Tulving & Thomson, 1973), a 'reduction matrix' is a descriptive representation of a memory 'trace'. The organizational composition of the 'memory trace' is described by the valences. The portion of the circle labeled 'Reduced Valence Complementary' represents the proportion of words recalled only in the presence of complementary cues. Reduced Valence similarity represents the proportion of words recalled only in the presence of similarity cues. The Common Valence represents organization which is shared by the two cue dimensions (the proportion of words recalled to both cues). Finally, Not complementary-Not Similarity represents trace organization which was inaccessible with these cues.

In Table 2, the results of the reduction analyses for this experiment are presented. The data were collapsed across both lists of words to obtain a matrix for each age group. As you can see, the 'common' valences accounted for a large proportion of recall for all age groups. This indicates that 'complementary' and 'similarity' did not really represent unique dimensions for subjects. The pattern of reduced valences is also similar for all age groups. Similarity cues were slightly better facilitators of recall for all subjects.

The Tulving & Watkins (1975) reduction matricies are highly informative since <u>patterns</u> of recall may be specified. Traditional statistical comparisons may also be performed on this data. We tabulated the number of words recalled overall to complementary cues and to similarity cues for each age group. These percentages are presented in Figure 2. We determined that there were no order effects of cue presentation, so we collapsed recall over order and treated cue type as a within subjects factor in an Analysis of Variance. The main effects of age and cue type were both significant, but the age x cue type interaction was not. Clearly, our results do not support Denny & Ziobrowski's (1972) complementary-similarity shift with age.

The results of Experiment 1 indicated that children and adults do not differ in the ability to use complementary and similarity dimensions for aiding recall. It is possible that children and adults may <u>prefer</u> to use these dimensions differentially, however. In our next experiment, we used a free recall paradigm which allowed us to assess preference for clustering dimensions contained within the same list. We constructed two 24-item lists for this task using all the target items and cues from the lists in the cued recall experiment. Each list contained eight three-item categories consisting of a target word, a complementary associate, and a similarity associate. Needle-thread-sew, for example, constituted one experimenter-defined category. We were interested in finding out whether subjects would cluster together in recall all three items from a category or whether their clusters would consist of pairs representing either a complementary relationship or a similarity relationship, (i.e., needle-sew vs. needle-pin).

These lists were given to third graders, sixth graders, and college students in a multitrial free recall paradigm. Each subject was given one list for four presentation-recall trials.

We computed an overall measure of clustering (Cole, Frankel & Sharp's, 1971, Z-Score) and found organization to increase significantly over trials for all age groups. In Figure 3, the mean levels of clustering are shown for each age group across trials. Clustering scross for the different age groups may be compared directly because the z-scores were obtained by normalizing with respect to levels of recall. As you can see, clustering increased for all age groups across trials, but the increase in clustering was greatest for college students. In an analysis of variance conducted on the z-scores, this age x trials interaction was significant.

If you turn to Table 3 you will see why this was the case. To determine the sources of the increasing organization across trials, we tabulated the proportion of recall accounted for by single items, pairs and triplets. Third graders' increases in organization were related to an increase in the use of pairs across trials, while college students' increases in organization were related to increases in three-item clusters across trials.

Recall of pairs was further broken down into complementary pairs and similarity pairs to see if either type of organization was advantageous. Sign tests conducted on the number of words recalled as complementary pairs or similarity pairs indicated that these dimensions were not used differentially by any of the age groups on any of the trial.

Let me summarize the results of these experiments. In the first experiment, we used a cued recall paradigm to assess patterns of memory organization within the same subjects. We fould no differences with age in the ability to use these associative dimensions. In the second experiment, preference for clustering dimensions was assessed using complementary and similarity relationships as a within-list effect. Again, no evidence was found to indicate that, for any age group, one dimension was spontaneously chosen or prefered over the other dimension in forming clusters during free recall.

Two conclusions may be drawn from these studies. First, these within subjects measures are powerful in assessing developmental differences in attribute encoding. The relative utility of different organizational dimensions may be compared directly using these paradigms. Secondly, children's abilities to use different organizational dimensions for aiding memory may exceed that which has been found previously. In these studies, no differences were found between children and adults in ability or preference to use complementary and similarity criteria for encoding.

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Table 1

Experimental Lists for Cued Recall Task

List 1

Target	Complementary Cue	Similarity Cue
Hammer	Nail	Saw
Crib	Infant	Cradle
Float	Light	Sink
Open	Door	Close
Needle	Thread	Pin
Horse	Gallop	Pony
Apple	Core	Banana

List 2

Target	Complementary Cue	Similarity Cue
Coffee	Drink	Tea
Bicycle	Ride	Wagon
Shovel	Dig	Spade
Hen	Egg	Chicken
Photo	Camera	Portrait
Thief	Jail	Robber
Sad	Cry	Happy
Rock	Hard	Stone

Figure 1

Schematic Representation of a 'Reduction Matrix'

(Tulving & Watkins, 1976)

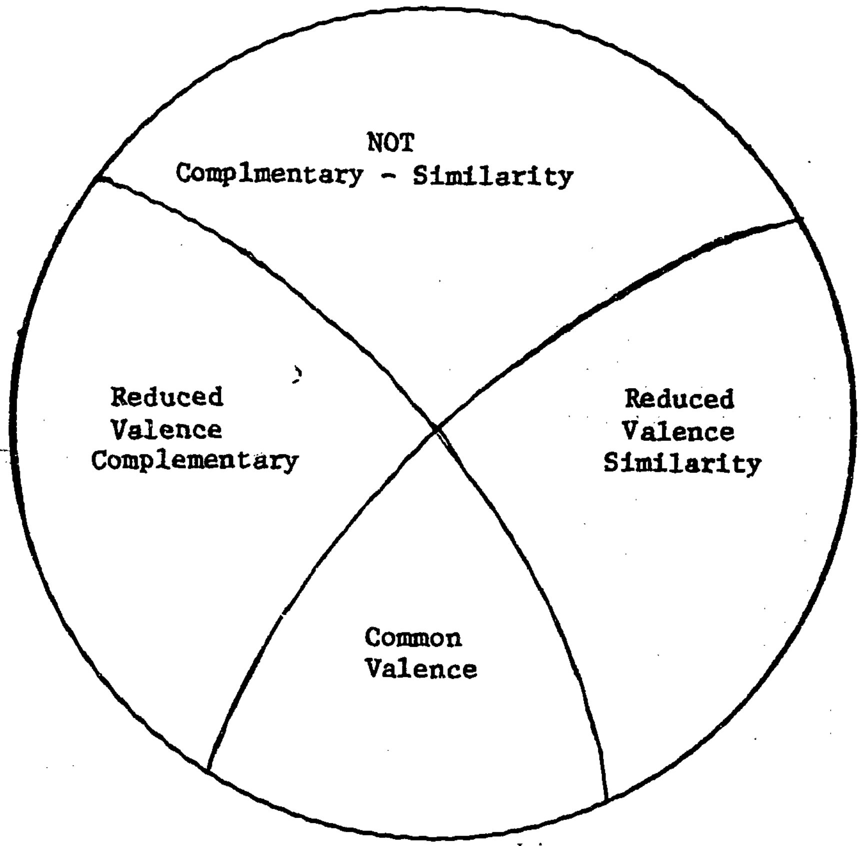
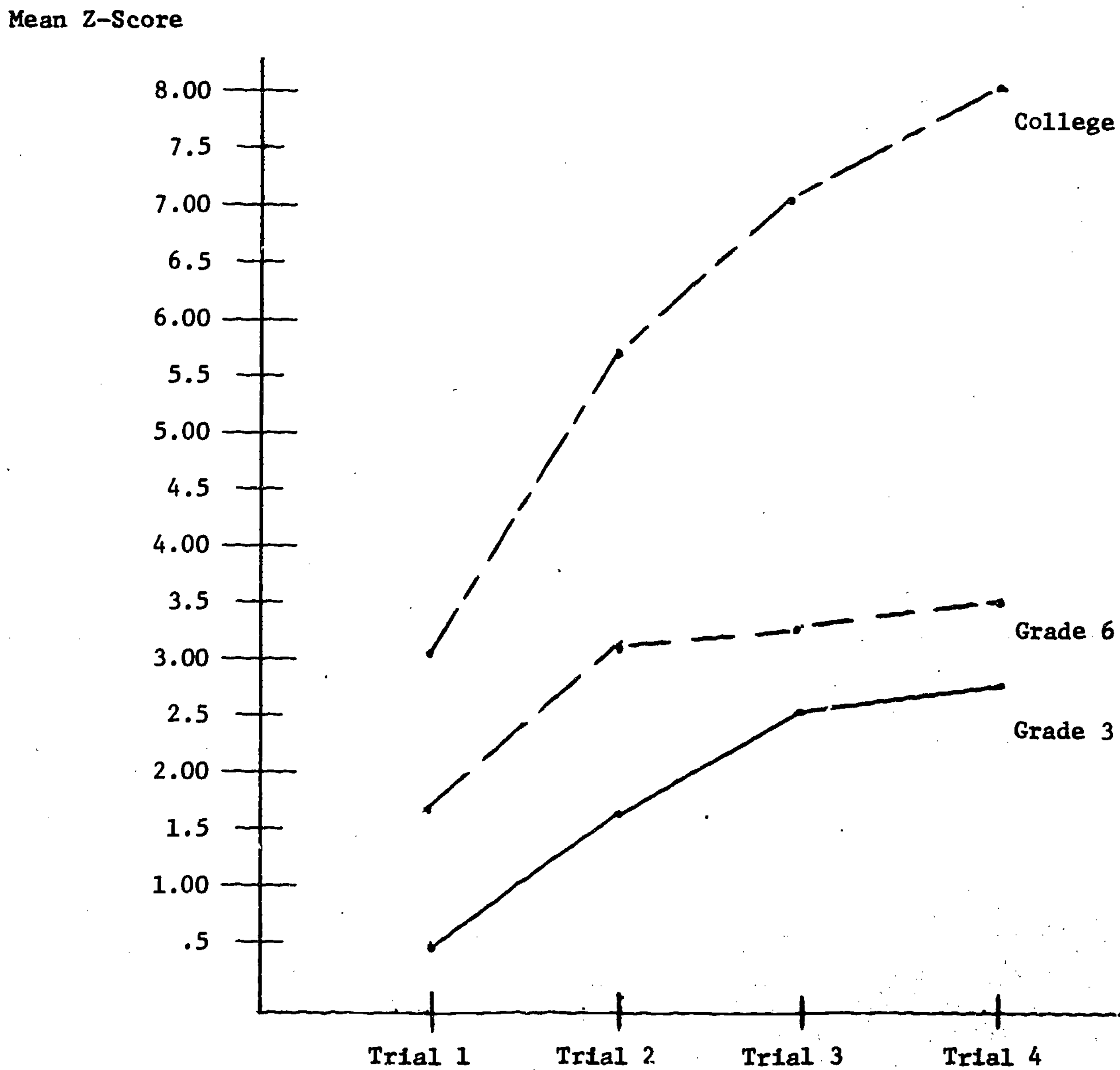


Figure 3

Patterns of Clustering Across Four Trials

for Preference Recall Task



Z-Score measure of clustering (Cole, Frankel & Sharp, 1972)

Table 2

Reduction Matricies

	Grade 3	Grade 6	College
Reduced Valence Complementary	.09	.13	.14
Reduced Valence Similarity	.23	.22	.26
Common Valence	.24	.30	.29
Not Complementary-Not Similarity	.42	.35	.32

Figure 2

Percentage of Targets Recalled to Complementary

Cues and Similarity Cues

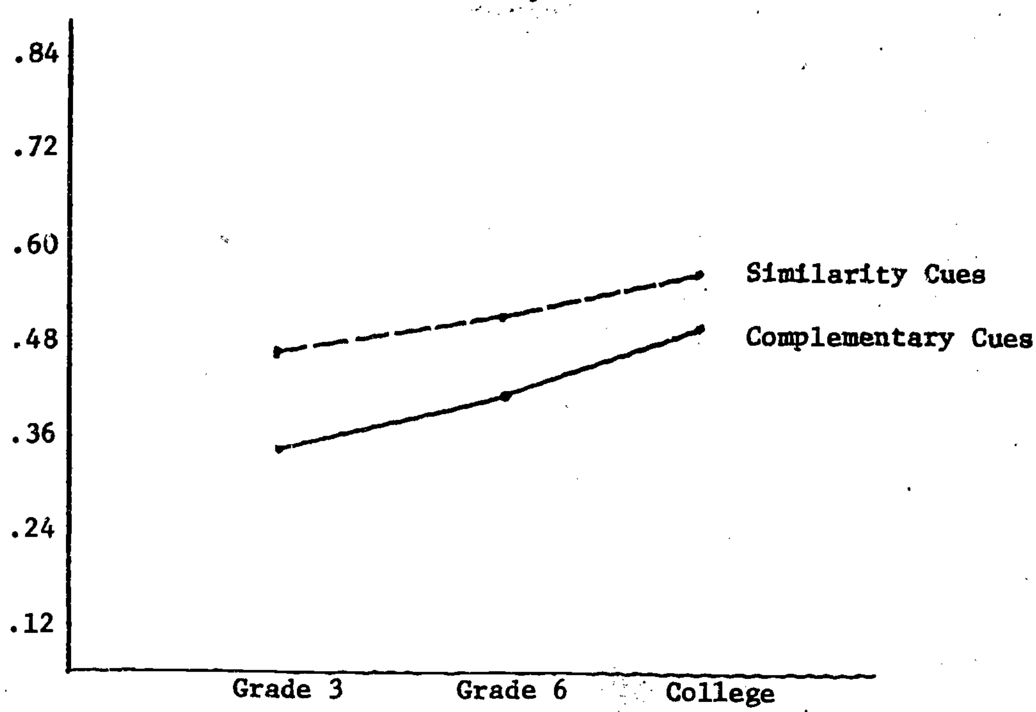


Table 3

Proportion of Recall Accounted for by

Single Items, Pairs, and Triplets

Grade			Singles	Pairs	Triplets
3	Trial	1	.65	.29	.05
		4	.47	.38	.14
6	Trial	1	.52	.41	.06
		4	.40	.40	.19
College	Trial	1	.27	.39	.34
		4	.13	.17	.70